MISCELLANEOUS REPORT No. 12

A S U R V E Y

of the

USE OF NATIVE WOODS AND OTHER BUILDING MATERIALS ON SOUTHERN MINNESOTA FARMS

By John R. Neetzel, Forester

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Lake States Forest Experiment Station

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Most Minnesota farms contain a number of buildings, fences, and other structures which require a continuous supply of wood or equivalent material for maintenance, replacement, and new construction. Many of these farms also have woodlands which could supply much of the material needed.

To learn how much farm wood-lot products have been used in a representative area and the possibilities of their greater use, a study was made during 1948 on 80 typical farms systematically selected in southeastern and central Minnesota. Included were 8 farms each in Goodhue, Olmsted, Rice, Wabasha, and Winona Counties; and 5 farms each in Benton, Chisago, Isanti, Kanabec, Mille Lacs, Morrison, Ottertail, and Todd Counties.

On each farm the owner or tenant was interviewed on lumber use so as to assemble a cross section of experience and farmer attitudes on as many as possible of the following points:

1. Amount of woodland, and the species, size, and quality of the timber in the farm wood lot.

2. Kinds of new buildings, and maintenance needed or planned.

3. Remodeling of older farm buildings.

4. Anticipated use of home-sawed lumber in these new structures, remodeling, and repairs.

5. Use of salvage lumber in farm buildings.

6. Past experience and present attitude of the farmer to the use of local lumber.

1/ The author made the study on which this report is based while on detail to the Forest Products Laboratory, Madison, Wisconsin. The initial typewritten report was submitted by the Laboratory as Research and Marketing Act Studies Report No. 6. The study was conducted with funds provided under the Research and Marketing Act.

2/ Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with the University of Minnesota, at University Farm, St. Paul, Minnesota.

7. Difficulty encountered in nailing and working local hardwoods.

8. Availability of sawmill, edger, and planer facilities.

9. Seasoning - access to custom dry kilns and adequacy of home-seasoning information.

10. Availability and attitude of local carpenters to the use of native lumber.

11. Experience with connectors and unconventional connections in farm buildings.

12. Farmer's experience with glued and built-up rafters and timber of native lumber.

13. Use of plywood and fiberboard on the farm.

14. Prefabricated buildings.

15. Use of native insulating material, such as sawdust, wood shavings, and straw, and the results obtained.

16. Farmer's experience with ventilation and condensation.

17. Present and prospective use of wood as a fuel for the farm.

18. Present and prospective use of fence posts from the farm wood lot.

19. Preservative treatment of fence posts and lumber.

20. Attitude of the farmer toward steel, aluminum, and similar substitutes for wood products.

21. Experience with paint on the various farm buildings.

22. Experience with roofing material and the type of material likely to be chosen for future roofing needs.

23. Failure of building materials, especially local lumber.

24. Extent native wood-lot products are handled by local retail lumberyards.

25. Marketing of native wood-lot products.

26. Need for additional research in the use of local lumber.

No attempt is made in this report to present quantitative data relative to these questions, since the study was aimed primarily to reflect prevailing experience and reaction concerning farm timber usage.

THE FARMS AND FARM WOODS OF SOUTHEASTERN AND CENTRAL MINNESOTA

So that the results of this survey can be more easily understood and interpreted, the farms and farm woods of the areas studied are described briefly:

Unlike the area farther west in Minnesota, nearly all land covered in the two study areas was timbered when white men first arrived. Most of the original timber has been cut, and perhaps three-fourths of the land has been cultivated. The woodland that remains is now a part of the farm wood lot.

Southeastern Minnesota

The southeastern Minnesota farms studied were in an old well-established dairy and mixed farming area. Many of them had been settled for as long as 100 years. The land is gently rolling to very steep along the many streams. The soil is rich but has been badly eroded on many farms. A large proportion of the farms studied were not owned by the occupants. The farm structures are fairly well correlated with land values and farming needs.

In the five southeastern counties, there are more than 250,000 acres of farm woodland (table 1). Slightly less than half the farms still have wood lots, most of which contain some sawlog material.

A large part of the wooded area is heavily grazed and in poor growing condition. Oak is the principal forest type, but there is a small acreage of bottom-land hardwoods and some northern hardwoods. Red and white oak, elm, basswood, cottonwood, ash, soft maple, hickory, and juniper are the principal species.

Because of grazing and logging practices, the area of good sawlog timber is rapidly decreasing. Many farms no longer have any trees except for shade in the pasture and the farmstead grove.

Central Minnesota

On the central Minnesota farms, mixed farming is generally practiced, with dairying of main importance in many localities. Most of the settlement in this area has taken place since about 1880. Many farms were settled from 1900-1920. The land is generally level to gently rolling, with many small lakes and swampy areas. The soil tends to be light and sandy, and where it is heavier there are often many rocks. Most of the farms studied in this area were occupied by their owners. Nonfarm income was used to develop many of these farms, with the result that buildings are frequently more pretentious than the soil and farming practices now justify.

The eight central Minnesota counties have more than 750,000 acres of farm woodland (table 1). About two thirds of the farms still have wood lots. Part of this acreage is grazed and in poor growing condition.

Table 1.--Woodland area and volume, southeastern and central Minnesota

Area	Total woodland 1/	Farms with woodland 1/	Total land area in woodland 1/	Average size woodland per farm	Average volume per acre 2/	Farms contacted with woodland
	Acres	Percent	Percent	Acres	Bd.ft.	Percent
Southeastern Minnesota.....	275,866	48	14	24	800	70
Central Minnesota.....	756,555	64	18	34		75

1/ Bureau of the Census - 1945.
2/ Forest Survey, Lake States Forest Experiment Station - 1936.

Oak, northern hardwoods, bottom-land hardwoods, and swamp types all occur. Most of the area was heavily burned following logging, prior to general settlement, and the aspen type is quite common.

Red and white oak, elm, basswood, ash, tamarack, white, red and jack pine, cedar, cottonwood, and aspen, are the principal species.

At the time of settlement many of these farms were covered only with brush and small trees. The lumber for the buildings was purchased. Today many of these same farms have sawlog-size timber in the wood lots, although the trees generally are smaller and the stands inferior to those found in south-eastern Minnesota.

USE OF NATIVE LUMBER ON THE FARM

A typical farm contains one or more dwellings, one or more barns, and usually numerous minor buildings such as granaries, machine sheds, garages, hog houses, milk houses, poultry houses, cattle sheds, corn cribs, silos, and miscellaneous buildings. Normally there is a continuous need for lumber to maintain or replace these buildings or to construct new ones.

Apparently most farmers do not appreciate the possibilities of having better farm buildings through the greater use of lumber cut from their own woods.

While native hardwood lumber was commonly used in the buildings on several of the farms studied, and some farmers are continuing this practice, others, with equally good wood lots, have used very little local lumber.

In the past, the use of home-grown lumber has depended mostly upon the ambition, experience, and attitude of the owner. Today cost is an important consideration.

Perhaps the greatest drawback to the use of native lumber is not the availability of the timber or sawing facilities, or even the "know how" or desire to use local lumber, but the failure to plan buildings in advance of construction.

Most farm-building repairs are made when funds are available. Most new construction is done on short notice to replace losses due to wind or fire, or to house "bumper" crops. These buildings are not usually anticipated in advance and native lumber is not accumulated to meet the need. They are rush jobs and much of the material must be obtained from the local retail lumberyard.

Use of Salvaged Lumber

Not all farm construction is with new lumber. Often lumber salvaged from old barns or other buildings is available and consequently native lumber cut years ago may be put to new use.

There appears to be a greater salvage of lumber from farm buildings in southeastern Minnesota than in central Minnesota. Most of this salvage is from roof boards, haymow floor joists and rafters of old barns. Native hardwood, together with some northern white pine, makes up the bulk of this salvage material. Most of the framing for a new modern barn frequently is salvaged from an old barn.

Occasionally, after heavy windstorms, salvage lumber from destroyed buildings is used for construction of complete buildings, even houses.

Remodeling Farm Buildings

Helpful bulletins and plans provided by the State Agricultural Experiment Station and other agencies are available to guide farmers in remodeling their homes. Comparable plans for remodeling barns and other farm buildings, however, are generally lacking. Because of changes in equipment, methods, etc., past experience is no longer a reliable guide. For example, a barn built more than 30 years ago, before tractor farming, has many features which are now unsatisfactory. Several large horse stalls are not needed. Less grain and hay storage is required. A center driveway is desirable so the barn can be cleaned and the manure hauled directly to the field. If hay is chopped or baled, an increased load is often placed on the haymow floor and additional bracing is required.

Also, a granary built 30 years ago had alleys and stairways for carrying the grain. Today, the grain is elevated and much room could thus be saved for storage.

These are features in remodeling in which every farmer needs help if he is to make adjustments in his physical farm plant. Every building is a special case, but many basic principles are known and could be incorporated in a handbook. The need for information on the basic design of the various types of farm buildings was mentioned by several farmers. Simple one-sheet general plans for use of lumber (native lumber where available) such as furnished by the Portland Cement Company for cement-block construction, were suggested. These would enable the farmer to complete the plans for any building.

Experience of Farmers with Local Lumber

There is a general belief held by many farmers and encouraged by retail lumber dealers that native lumber is not as durable as purchased pine or fir lumber, especially for hog houses, poultry houses, and first floors of barns where excessive moisture promotes decay. It is undoubtedly true that native lumber contains considerable sapwood and is frequently of less durable species so that it does not resist decay well under moist humid conditions unless it is specially treated. However, native lumber, properly used, lasts a long time. Several barns, 40 to 80 years of age, were visited in this study and in most of them native hardwood rafters and roof boards were still in good condition.

Most farmers also believe that native hardwood lumber is not satisfactory for outside use as siding. Part of this dislike may arise from using rough lumber. It is true that where horizontal siding is used, native hardwoods have not been too successful. On the other hand, there are many examples of vertical stock boards still in good condition on barns and other buildings 40 to 80 years old. Drop-siding walls on farm buildings observed have not stood up as well as lap-siding, and neither are as durable as vertical stock boards.

Despite these prejudices, farmers frequently use native lumber when it is cheaper than other materials. If the timber is available on the farm or can easily be obtained nearby at a lower cost, most of the framing and rough lumber often is cut from the wood lot. In most cases, however, material for siding is purchased.

Many farmers consider that the only place native hardwood lumber is entirely satisfactory is in the framing of garages, granaries, and machine sheds, and in roof boards for these structures.

Difficulties in Nailing Native Lumber

Some difficulty has been experienced by farmers in nailing native lumber, but this has not been a limiting factor in its use. A few farmers have greased the nails, but none contacted had heard of using blunted nails. Several farmers mentioned the possible use of electric drills to facilitate the nailing of dry hardwood lumber. This may be feasible, as most farms now have electricity.

Construction on Sample Farms

The general impression that there is currently a large amount of farm building and repair work was not borne out by this study. While new homes in towns were frequently observed, only one was seen on a farm in the course of these contacts. Many buildings were noted which needed repair, but the farmers planned to do no such work as long as the buildings were usable. Many farmers would like new buildings and extensive repairs, but cheaper building costs, especially labor, will be necessary before any large-scale farm building program can be expected.

Of the 40 farms visited in southeastern Minnesota, only 3 major farm buildings (2 barns and 1 house) were planned for the immediate future as follows:

1. One farmer was tearing down a wooden barn from which he will salvage most of the lumber (largely pine) for a new barn. Hollow tile will be used for the first floor wall and foundation. Some native lumber will be purchased from a small sawmill owner. Galvanized iron will be used on the walls. Although there is a small wood lot on the farm, the owner believes he will be too busy with the salvage operation to find time to cut trees from the wood lot.

2. Another farmer plans to replace an old barn in about 2 years. He is now accumulating a supply of air-dry native hardwood. The old barn will be used for other purposes.

3. Another farmer indicated he would replace his house as soon as building costs come down. Although there is a good oak wood lot on this farm, the farmer does not plan to use native hardwood lumber, as he does not believe it is satisfactory for house construction. This same farmer erected an all-steel granary early in 1948.

In this same section a considerable number of granaries, machine sheds, corn cribs, and garages are being built and planned for the next year or two. Much native lumber, chiefly oak, will be used in all parts of many of these structures, except the outside siding, and also in the maintenance and repair of other buildings. Some lumber is being cut from grove and shelter-belt trees, as well as farm wood lots.

None of the farmers contacted in central Minnesota had more than tentative plans for constructing new major farm buildings. One farmer indicated he would use native lumber when he built, but the majority planned to use purchased pine and fir. Some native lumber is being used for repairs and maintenance, and for putting up small buildings.

In central Minnesota where there is some pine or tamarack left in the wood lots, less hardwood is used and there is a concentrated "run" on native pine.

Manufacturing Local Lumber

Sawmill facilities are generally adequate throughout both central and southeastern Minnesota, with some 275 mills (mostly portable) cutting nearly 15,000 M board feet in 1945. Several of the mills move many times during the year, and no farm is more than a few miles from a sawmill "setting". Most of these mills are owned and operated on the farms and do mostly custom sawing. Sawing is generally considered satisfactory, although it is believed that central Minnesota mills do somewhat better sawing than those in southeastern Minnesota. 3/

3/ It is doubtful if the farmers' standards for sawing are sufficiently high to secure a good product from the log.

There are more edgers attached to the mills in central Minnesota, but the bulk of the edging is done on the headsaw.

There are only one or two stationary planers in each of the southeastern Minnesota counties. In central Minnesota, there are, perhaps, twice this number and several of these are portable and move from farm to farm, the same as the custom sawmill.

Many farmers asked how long lumber should be dried before used for framing and covering buildings. Some have used green lumber because it nails better and eliminates the need for piling and drying. Others use near-dry lumber. Most farmers dry lumber for at least a few months.

Most farmers do not dry native lumber properly. Usually only a few thousand feet are sawed at a time and boards of several sizes are mixed in the same pile. Furnishing the farmer with a diagram or plan for piling or packaging small quantities for drying would be helpful.

Dry-kiln facilities are scarce. Only four kilns are known to be operating in southeastern Minnesota, and two or three in central Minnesota. These are largely occupied with the drying of commercial products, such as furniture or flooring, and are not regularly available for drying home-sawn lumber.

Attitude of Local Labor Toward Native Lumber

City carpenters, who do relatively little farm building, dislike using native lumber. However, most farmers, and their neighbor helpers, who do the bulk of farm construction, are not prejudiced against the use of native lumber if it is properly manufactured and seasoned.

More than half of the 80 farmers contacted do all their own carpentry work and more than three-fourths of them do all the painting. Where help is hired, it is usually a neighboring farmer who likes to do carpentry work and has had more experience. The farmer-carpenter who hires out, in turn hires a laborer to do his farm work while he is away from home.

Of the 80 farms visited, only one building (a barn) had been built under contract, and this without a blueprint. Simple plans or examples from neighborhood practices are more often followed. Labor costs of farm buildings are consequently low.

Use of Glued and Built-Up Members of Local Lumber

Farmers generally have been slow to accept new developments in the use of lumber and wood products. While lack of advertising in farm channels may be part of the reason, the main one is that most farmers do most of their own building and repair work; and it is much easier for them to continue with the materials and practices with which they are familiar.

It is unfortunate that greater use has not been made of built-up rafters and beams for the round barn roofs which farmers generally like. Much of the farm wood-lot lumber is short-length mixed hardwood and aspen, which could be used to good advantage in these built-up units. On the 80 farms visited, no glued rafters had been used, and only two farms in southeastern Minnesota had used built-up rafters--these were 3-ply nailed oak for a large machine shed and similar rafters for a barn.

In central Minnesota at least 10 percent of the larger farm buildings (on about 1,000 farms observed) contain built-up rafters of native lumber. Most 3-ply (1x8 boards) rafters are satisfactory, especially those which contain bolts. However, those made of 6-ply 1x2-inch strips have generally failed even when bolted. There is ample evidence that built-up rafters also need bracing, but none of the farmers contacted knew how to do this bracing.

Native hardwood lumber is excellent material for built-up rafters. Probably more would be used if adequate information were available on the methods of sawing, nailing, and spacing in the roof. Several farmers inquired about the need for clinching the nails, driving them at an angle, and the size and type of nail which should be used. The minimum width after sawing the curved surface is also a factor in strength which could be corrected by using shorter length lumber. Inquiry was also made regarding the planing of the center board to secure a uniform fit.

A few farmers contacted had used short-length lumber to build up posts and beams. Most farmers reasoned that since built-up beams were satisfactory, built-up posts would be equally strong. Many such posts are in use. The number of these built-up members will increase as smaller trees are being sawed for lumber.

Failure of Building Material, Especially Local Lumber

The farmers are at least partly right in believing that native lumber should be used only in "dry" buildings, such as garages, granaries, and machine sheds. Not only native lumber but all lumber suffers from use in damp barns and hog houses. Proper use of a moisture barrier paper would prevent moisture condensation in most parts of farm buildings. Proper use of this paper would increase the use possibilities of native lumber.

Many round barn roofs in the area sampled have shifted out of shape or have sagged. The sagging is quite evident near the middle of the roof around the cupola. In nearly all cases rafters are made of native lumber. These failures should not, however, be attributed to the material used but to the type of construction and lack of adequate bracing.

Several houses were noted with stucco, which had failed, over wooden lath. No failures of stucco over metal lath were noted. Many houses with satisfactory stucco also may have used wooden lath, but none were found in the survey. So far as is known, none of the lath used was made of native wood.

Failures of other types of building material are discussed elsewhere in this report.

OTHER WOOD-LOT PRODUCTS IN USE

Lumber, while important, is not the only wood-lot product used on the farm. Fence posts, fuel wood, insulating materials, and other products also contribute to farm income either through sale or through use in place of purchased materials.

Present and Future Use of Fence Posts From the Farm Wood Lot

Ten or more years ago, most farm fences contained posts cut from the local wood lots (oak in southeastern, and cedar, tamarack, and oak in central Minnesota). This was one of the more important crops harvested from the wood lot. As the wood lots have been cut over, the supply of the more durable species, such as cedar, tamarack, and oak have decreased. Instead of treating inferior species and using them for posts, many farmers have purchased steel posts.

Farmers who have used steel posts seem to prefer them for temporary fences. Steel posts are easy to drive, easy to pull, and wire can be quickly removed. With modern farming methods and rotating fields and crops, fences are moved frequently, and steel posts are a convenience. Steel posts are also more satisfactory than wooden posts in rocky and root-filled soil, but wooden posts will no doubt continue to be used for corner and gate posts and for barnyard fences.

In southeastern Minnesota, where perhaps a quarter of the posts in all active fences now are steel, their increased use occurred largely during the past 10 to 15 years. However, about half the farmers contacted in this section of Minnesota use mostly white and bur oak for fence posts, and most fences include some oak posts. Likewise, most fences also have some steel posts, and about a third of the farmers prefer them. Cedar and tamarack posts are not used extensively in this area, and only a very few nondurable tree species have been used for posts.

Southeastern Minnesota farmers expressed an interest in sharpened, treated wooden posts if cheaper than steel posts, but they were not interested in treating their own posts. Central Minnesota farmers, on the other hand, were interested in treating their own rather than buying treated posts.

The development of economical, rapid post peelers and sharpeners may encourage the use of wood posts. Sawing square, smooth posts from the more durable heartwood of large knotty logs is suggested.

Several farmers sharpen their posts on a circular wood saw, and more would do so, especially where the posts are set in sandy soil, if they knew how.

The amount of fencing is decreasing, and the use of posts is decreasing even faster since the horse, which was the prime destroyer of fences, has disappeared from the pasture, and not so many posts are needed for cattle fences. The increased use of electric fences also reduces the post consumption, both in numbers and the size used.

Central Minnesota farms appear to have more and poorer fences than the comparable farms in southeastern Minnesota.

All farmers contacted agreed that posts now cut from the wood lot, as well as those purchased, are inferior in quality and last but a fraction as long as the posts used by their fathers. This is probably due to the increased amount of sapwood in present-day posts, which are cut from second-growth stands and often from open-grown trees.

The development of a program of improved pastures, which will permit the elimination of fences around wood lots, will greatly reduce the fencing needs of most farms and still protect the wood lots from concentrated grazing.

Present and Future Use of Wood as a Fuel for the Farm

Wood was used almost exclusively as a fuel in southeastern Minnesota farm homes up until about 1940. Since then, the drift away from wood as a fuel has been rapid. About half the houses are now heated with oil and most of the rest with coal. Only a few farm houses now use wood exclusively for fuel. The installation of central heating plants has encouraged a switch to fuel oil and coal, which are more convenient to use. At the same time, rural electrification has given many farm houses an electric stove, and use of wood as fuel for cooking has decreased. Most modernized farms no longer have a year-round hired man and, therefore, do not have labor to cut wood. Most farmers indicated they had no intention of switching back to wood as a fuel. On the other hand, several who now use wood plan to shift to oil or coal stoker.

In central Minnesota, conditions are somewhat different and wood continues to be the principal fuel. Electricity has been slower in coming, so there are fewer electric ranges. Central heating systems are less common. The trend to other fuels found in southeastern Minnesota, however, is evident here also, and in a few years other fuels will be used more extensively than wood.

The development of an efficient, simple wood-heating unit, using a stoker to feed wood chips, seems to be the best hope to save the fuel-wood market on the farms. The development of economical portable chippers, which would go from farm to farm, like the portable feed mill, is also a possibility.

Most farm wood lots have an abundance of wood suitable only for fuel or chips. There is no market for this material in either central or southeastern Minnesota, and its lack is a serious blow to sound wood-lot management.

Use of Native Insulating Material

For many years farmers have tried to make the walls and ceilings of buildings warmer by various means. Straw lofts in poultry houses are the most common insulating practice on Minnesota farms.

Double-wall construction, lining with adobe brick, native grass, hay, straw, flax straw, sawdust, wood shavings, paper, cedar bark; and, more recently, commercial insulation, such as rock wool, have all been used in chicken houses. Double-wall construction, paper, and straw have been tried in hog houses. Double-wall construction, paper, and sawdust have all been used in barns. Newspaper, building paper, and planer shavings were used in the older houses; while more recently over half the houses have been insulated with mica, balsam wool, or other commercial insulating material.

A warmer building is the only measure used by the farmers to evaluate the insulation job. Moisture conditions in the walls and ceilings were not considered since the walls were not open so this could be observed.

PRESERVING WOOD PRODUCTS

Lumber in farm buildings usually is painted to keep it dry and to preserve it from rot. Fence posts of nondurable woods ordinarily will not last long unless they are given a preservative treatment.

Experience with Paint on Farm Buildings

Paint performance has not been satisfactory to most farmers, and the cost is considered high. The other parts of a building, including the shingles, last from 40 to 50 years, while it is considered necessary to renew the paint job perhaps 8 to 10 times in the life time of the building.

The farmer buys paint to protect his buildings from sun, rain, and decay. This paint is sold him as an impervious cover to keep the wood dry and thus prevent rot. Some farmers reason "the more expensive the paint, the better it must be." White house paint normally lasts 4 to 6 years on the house. It looks "nice" so it often is put on the barn and other buildings. On many farms all buildings are the same color as the house. Often the paint has stood up well on the house, and perhaps the garage and granary, but has more or less failed on the animal-housing buildings because of moisture from within.

There is a vast difference in the durability of paint on various sides of farm buildings, especially those which house livestock. The north and west sides of many barns, chicken houses, and hog houses, fail first due to moisture from within. The south or east sides of granaries or corn cribs often fail first apparently due to sun exposure, especially in the early morning on moist surfaces. Often it is necessary to repaint the entire building because of a failure on a relatively small part.

Farm-building maintenance and construction is correlated more closely with good crops and prices than with housing needs. Consequently, in periods of poor crops and low prices, very little painting is done. The buildings are soon run down. Repainting later becomes more difficult and costly, and may be put off indefinitely. Most farmers contacted considered the maintenance of a good paint surface an expensive item in farm-building upkeep.

During the past 10 to 20 years, many farmers have put on an additional covering over the outside of the walls to help "protect the buildings and keep them warmer," and also to eliminate the need for future painting. These materials include building paper, usually with a brick or stone pattern, asbestos shingles, wood shingles, galvanized iron, aluminum, stucco, brick, hollow tile, and stone face. These coverings can be added in years when cash is available, and charged off against maintenance on the income tax. Future painting is not necessary. One or more buildings on most farms now have such wall coverings. The use is rapidly increasing and several farmers expressed the intention of covering all the buildings as rapidly as possible. These wall coverings are easily put on by the farmer, about as quickly and cheaply as he can paint. Furthermore, he considers them permanent improvements that will last as long as the building.

It would be unfair to attribute all covering of buildings to reducing paint costs. Such coverings also tighten the walls and make buildings warmer.

The tendency to cover buildings is not limited to the farm. In a small community of 1,000 population, 14 houses could be counted from one location with paper siding, stone pattern.

There were several examples where vertical stock boards (oak, white pine, ash, and even cottonwood) have been in use for 50 to 75 years without ever being painted, and the boards are still in good condition. On the other hand, beveled and drop-siding which have not been kept painted have deteriorated rapidly.

Most painting until the last few years was done with a brush. Most communities now have spray-painting outfits, some of which have been used on farm buildings. However, most of the home spraying of farm buildings is done with small home-owned outfits (made easy with REA on the farms). Several of the farmers contacted had such small paint spray machines. The small spray painters are especially useful in machinery maintenance.

The majority of the farm buildings inspected needed painting, and many of them had been unpainted for long periods. Most farmers were of the opinion that buildings ought to be painted every three to seven years, and most of them apologized for not painting that often. They painted their houses more frequently than any other buildings.

Each farmer contacted was questioned regarding his preference for lumber treated with preservative or stains, rather than paint. Many were interested, and all thought such lumber would be satisfactory for all buildings except the house. They desired paint, asbestos shingles, or similar "showy" siding on the house. This use of treated lumber deserves investigation and demonstration. Native, unplaned lumber could be used to good advantage in such structures.

Preservative Treatment of Fence Posts

As the local supply of durable woods for fence posts decreases, farmers must turn either to steel posts or treated wooden posts.

Treatment of some nondurable species has been done successfully, but no widespread post-treating program has been developed. None of the 80 farmers contacted in southeastern or central Minnesota, or their immediate neighbors, had ever used treated posts or attended a post-treating demonstration.

Several farmers contacted had painted creosote on a few corner and gate posts. None were sure that treatment was beneficial, but most of them believed that it was. Perhaps half the farmers had charred the butt end of green posts as soon as they were cut, and all who had used such posts believed they lasted longer, especially in sandy soils.

The relationship between sapwood and decay is not understood by farmers, and this seems to be the chief reason why they have not gone into extensive fence-post treating programs.

About half the farmers in southeastern Minnesota (where posts chiefly of durable woods have been used in the past) indicated they would purchase treated posts if such were readily available on the local market and cheaper than steel posts. They would like wooden posts sharpened with a long taper.

None of the farmers in central Minnesota expressed an interest in purchasing treated posts on the local market. In this section, however, many farmers are accustomed to set and maintain fences using nondurable tree species. Discarded treated railroad ties have been used for corners and gate posts, and even in line fences. One farmer used granite corner posts weighing several hundred pounds each.

During the thousands of miles traveled and hundreds of rural contacts made in southern and central Minnesota through June 1948, the author has never observed treated posts in a farm stock pile or set in a farm fence.

Preservative Treatment of Lumber

No pressure-treated lumber had ever been used on any of the farms visited. Moreover, as far as could be determined, no preservative treated lumber or shingles have been sold in any of the local retail lumberyards.

One farmer had dipped the end of haymow floor joists in creosote prior to setting them in the hollow-tile wall. Several have painted creosote on corn cribs, hayracks, and other exposed wood surfaces. All believed these treatments retarded decay.

SUBSTITUTES FOR FOREST PRODUCTS

While the average farmer has been slow to accept new uses of wood and wood products, he has readily accepted substitute materials. From the group-wise distribution of certain products, this would appear to be probably the result of advertising and salesmanship. For example, many farms in one community may have metal cupolas, while a few miles away there may be a group of farms with metal side walls and roofs. Metal granaries, also, are usually found in groups.

Galvanized iron, aluminum, composition shingles, building paper, brick, cement, and tile products are finding increased use on Minnesota farms. These materials are used both as a substitute for wood products, such as shingles, siding, and side-wall construction, and also as an additional covering for convontional wood structures.

Use of Metal

To determine the extent to which substitute materials are used, a tally of the buildings on which galvanized iron and aluminum had been employed was kept during several hundred miles of travel in southeastern Minnesota. These materials were chosen since they could easily be distinguished from the highway. Comparable results doubtless could have been obtained from a tally of composition shingles, building paper, or cement and tile products. The tally of 1,237 farms gave these results:

Use of Metal in Southeastern Minnesota Farm Buildings	Percent
Barns with metal roofs 1/	9
Metal roof or walls on same building	77
Farms with some metal roofs	74
Farms having metal side-walls on some buildings	22
Farms having both roofs and side walls of some buildings of metal	19

1/ Based on 681 farms.

Some of the 40 farms visited in this section used materials other than wood at the time of construction. Native stone foundations and side walls of various heights were most common. Two barns with galvanized iron roofs, several machine sheds, and other small buildings with metal roofs and side walls, a basement barn with hollow-tile side walls, and two all-steel granaries were other examples. Several cement-block garages are now being built. One all-metal granary has been used several years and a second is now under construction.

In most cases, however, the substitute materials have been added to the original wood structures to tighten the walls, to make the building warmer, to cover up poor and decaying side walls, and old shingles, or to eliminate the need for painting.

Most of the barns built in central Minnesota were constructed with a double wall on the outside of the studding with paper between. These have rotted badly and many should be replaced. Cement blocks or hollow tile are commonly used for this and a large number of the barns now have a nonwood first-floor wall. Newer barns in central Minnesota almost always have cement-block or hollow-tile walls.

Substitute Roofing Material

Most Minnesota farm buildings have cedar-shingle roofs, because the farmers prefer them. No farmers visited in this survey had used locally manufactured shingles or shakes, and there are no active shingle mills in the territory.

At present there is a strong trend to put on new roofs of composition shingles or metal, especially in central Minnesota. Reasons for this trend, according to the farmers contacted, are these:

1. Cedar shingles sold today are not as good as those available a decade or longer ago. (A better grade of cedar shingles is desired by most farmers.)

2. Present prices for cedar shingles are too high. Galvanized iron, aluminum, and composition shingles are usually cheaper when installation costs are included.

3. Advertising has stressed roofing material other than wood shingles, with an attendant increase in the sale of substitute roofing materials.

Farmers believe that composition shingles are more fire-proof than cedar shingles, and many prefer their bright colors.

On the other hand, many farmers recognize some deficiencies in the substitute roofing materials, such as:

1. Galvanized iron roofs usually leak around the joints and nail holes during heavy rain storms. Unless the nails are clinched, the sheets loosen and begin to rust where they rub.

2. Since metal roofs generally are cold in winter, moisture condensation is heavy in buildings housing animals.

3. Metal roofs present a snow problem. Where the roof is quite flat, the snow accumulates and comes down in huge snow slides, which are dangerous to both man and livestock. Where the roof is steep, the snow slides off currently as it falls. In either case, a large pile of snow accumulates at the side of the building close to the foundation. In contrast much of the snow falling on cedar and composition-shingle roofs remains where it falls, gradually melts and evaporates. The barnyard is not kept wet late into the spring by the melting of the huge snowbank as occurs with a metal roof.

4. Metal roofs usually are not suitably grounded against lightning.

5. In the western part of the State metal roofs are seldom found on any building. One farmer suggested this was because of danger from high winds and frequent hail storms.

6. On large barn roofs, composition shingles sometimes buckle. Even on smaller buildings they may loosen, blow up in high winds, and cause the roof to leak. Some of these failures may be caused by improper laying of the roof.

7. Substitute materials do not stand hail storms so well as do cedar shingles.

8. Cedar-shingle roofs seldom need replacement before 30 years and many 40- to 50-year-old roofs are still giving good service. Composition or metal roofs are shorter lived.

The extent to which various roofing materials are used on southeastern and central Minnesota farms is illustrated by a random tally made during the course of the study (table 2).

Table 2.--Use of roofing materials on southeastern and central Minnesota farms

Material	House roofs		Barn roofs	
	Southeastern Minnesota	Central Minnesota	Southeastern Minnesota	Central Minnesota
	Percent	Percent	Percent	Percent
Wood shingles	72	63	86	88
Composition shingles	26	35	3	7
Roofing paper	1	2	1	1
Metal	1	0	10	4
Total	100	100	100	100
Basis: Number of farms	(590)	(912)	(681)	(1,433)

USE OF NEW MATERIAL AND METHODS

Although farmers are slow to change to new materials and methods in building practices, in the area studied there has been some use of insulating materials, plywood, and fiberboard; also of prefabricated buildings.

Insulation and Ventilation of Farm Buildings

The relationship between insulation, ventilation, condensation, and the deterioration of buildings is not understood by most farmers. Accordingly, moisture condensation is accepted as a necessary evil during cold weather in buildings housing animals. Often an effort is made to make a building warmer by adding an extra wall covering (usually to the outside). This further closes off the natural "breathing" of buildings and adds to the moisture problem. Minimum ventilation of tilting windows or a cupola are available on about three-fourths of the buildings and planned ventilation on less than half.

Tightening of the building walls, making the building warmer, without providing adequate ventilation, creates a moisture condition in the walls and framing favorable to the rotting of the wood. Many examples were found of accelerated deterioration of buildings due to these conditions.

Farmers recognize three types of buildings as presenting ventilation and insulation problems, in this order of importance: poultry houses, hog houses, and the barn. To these should be added the farm house.

Available information on the relative insulating value of different building materials is not known of or used by farmers. Information is generally lacking, among both farmers and retail lumber dealers, on the values and proper uses of various building papers. If ventilation could be improved it would be easier to sell the use of native lumber in farm buildings.

Poultry Houses

Ordinarily, the poultry house is the best insulated building on the farm, because the need for a warm and dry poultry house is easily recognized by the farmer through such signs as falling off of egg production and the illness of the chickens. The University of Minnesota has recognized this poultry-housing need by development of plans for a straw-loft poultry house, which has been widely adopted as a result of Extension Service efforts. Where these plans have been carefully followed, double-wall side walls constructed, and adequate louvers installed over the straw loft, a fairly satisfactory poultry house resulted. Some farmers have substituted wood shavings for straw with even better results.

At least half the poultry houses observed in southeastern Minnesota have straw lofts. Cedarbark, flax straw, and shavings have also been used in the ceiling. These, along with sawdust, adobe brick, and commercial insulation, have been used in the side walls. Each of them keeps the building warm but induces trouble with rats, mice, and insects.

Many poultry houses in this section have been covered on the outside with heavy building paper, asbestos shingles, or galvanized iron, to keep them warm. Numerous examples of door, window, cupola, and flue ventilators were noted. None were considered by the owners to be either adequate or satisfactory.

The poultry industry is less developed in central Minnesota and the houses are generally small and poorly made. Straw lofts are used in some, but the side walls are not well ventilated. A double wall on the outside of the studding is the general practice. These walls are not as warm as those which are insulated and are subject to frosting in cold weather. Wood shavings which are readily available in the area are little used in the walls for insulation. Building paper is generally used on the outside of the building.

In no case observed has a vapor paper been used in connection with either double-wall construction or insulation.

Hog Houses

Hog houses are used mostly in southeastern Minnesota. All of the hog houses inspected were "wet" and "cold" during winter weather. None of them had any planned ventilation except small cupolas and windows.

Only one of the forty farms contacted had a double wall in the hog house. Another had an 8-inch hollow-tile side wall. The best hog house seen had a straw loft, which, however, was not entirely satisfactory because of rats.

Several farms had no hog house but kept the hogs in the part of the barn formerly used for horses.

All farmers recognized the need for a warm and dry hog house, but considered it more or less impossible to obtain. They recognized that double-wall construction causes the excessive moisture which might rot the boards. Moisture barrier paper is an unknown item in hog-house construction. None of the farmers contacted had ever considered using treated lumber in hog-house construction to reduce rot.

New hog houses often are made of cement blocks and hollow tile. This reduces the rotting problem in the side walls, but does not provide the warm houses which the farmer desires.

In hog houses more than a few years old, window casing and frames, and even rafters and roof boards, are often badly rotted. The type of hog house with roof windows is especially disliked because of heavy moisture condensation around the windows. On two farms visited, these windows had been removed.

A few hog houses were noted which had a wood or coal stove to dry out the building during early spring farrowing. Most farmers, however, raise late spring pigs, when weather conditions are more favorable.

On one farm visited, individual houses were used at the time of farrowing, and hogs slept in the straw pile the rest of the year.

Since hogs usually survive under cold, wet conditions, little improvement in building has been made.

Barns

Barns built before 1910 were more or less open and cold in winter. There was a ready exchange of air between the inside and outside, and they seldom became damp except in extremely cold weather. Most of these barns had little or no foundation, and the lumber which came into contact with the ground rotted.

Newer barns have been made increasingly tight (sometimes with double-board walls) with the result that they are warmer but become "wet" in cold weather. Ventilation has not kept pace with the increased moisture which is trapped in the walls, with the result that the lumber in many of the newer structures is rotting rapidly.

About 20 to 30 years ago, drinking cups and milking machines were installed on many farms. To keep water from freezing, roofing paper, composition shingles, and galvanized iron (later aluminum) were added to the outside of many of the older barns. Boards, building paper, and even brick were added to the inside walls. These new ideas in construction resulted in warmer barns, but also increased the moisture condensation in cold weather.

Some windows have been opened and an occasional cupola or ventilator added but, in general, ventilation is inadequate. Moisture barriers have not been used, and in many cases rapid decay has started in the walls, haymow, floor joists, beams, and even in the rafters and roof boards.

A good example of tightening a barn was found in Rice County. About 18 years ago, a 60-year-old set of farm buildings was torn down and rebuilt, using salvaged native lumber which was in excellent condition. The new barn was covered with galvanized iron and the insulation was inadequate. Serious rot has already started over the entire first floor of the barn. On a subzero day the boards and timbers are saturated with moisture. Similar salvaged native lumber used in a machine shed (on the same farm) and also covered with galvanized iron is still in good condition.

Loose hay in the mow has always formed a good ceiling insulation for most barns during the cold winter weather. New farming and haying practices have changed this condition on many farms. Horses are no longer kept and this reduces the amount of hay stored. Baled hay is stored in piles. Part of the haymow floor is now left uncovered and unprotected. This results in a colder barn and a haymow floor wet from condensation. The moisture may even be transmitted to the roof. When metal or composition roofing is used, condensation on the rafters and roof boards is often heavy. Several such examples were found on the study.

In southeastern Minnesota barns, no wall insulation was observed except for some double-wall construction, with a 4-inch air space and a layer of cheap building paper between. Most walls were single and cold and wet during the winter months. Side-wall decay due to moisture from within was not evident, but some decay of the floor joistsand beams was noted. Cupolas and windows are the only planned ventilation in most of these barns.

Double walls, with both boards having a layer of cheap building paper between them on the outside of the studding, were quite common in central Minnesota barns. These side walls in many cases are decaying from moisture from within the barn, the first point of failure in many of these barns. A layer of heavy building paper on the outside improves warmth but also speeds decay.

One barn had brick cemented between the studding for insulation. This keeps the barn quite warm but the bricks frequently loosen. Another barn had solid 4-inch timbers fitted between the studding. This keeps the barn warm but moisture condensation around the windows has caused extensive decay. On several farms, ceilings on the first floor of the barn are 9 to 12 feet high. Such barns are cold and unsatisfactory.

Paint failures were common on the bottom 8 to 9 feet of barn walls, especially on the north and west sides. This could be traced to excessive frosting of the walls.

House

The farmer has always wanted a warm house, but has never considered ventilation necessary. Asbestos shingles, building paper, and stucco have been added to the outside of many homes. About half of the houses now have commercial insulation (rock wool, spun glass, balsam wool, mica, etc.). In no case was the use of vapor paper noted. None of the farmers contacted had used weather stripping.

After talking with 80 farmers regarding insulation, it is obvious that they do not recognize what happens to the walls which are insulated--other than that the building gets warmer. All agree that improved insulation has resulted in a substantial saving of fuel.

Most of the better houses in southeastern Minnesota have been insulated with commercial insulation. Several farm houses had the walls insulated but not the ceiling. In no case was the ceiling insulated independently of the walls. These are good examples of "pressure selling". Less than half of the houses with ceiling insulation had louvers and most farmers did not realize the need for this ventilation.

Several farmers contacted in southeastern Minnesota had insulated their own ceilings. One had rented a blower and had also insulated the side walls. Several farmers expressed dissatisfaction with side-wall insulation, not because of the moisture problem (which they did not anticipate) but because the walls were not completely filled. One or two told of moisture in the insulation in other houses, but no such cases were contacted. One farmer used sawdust in the kitchen walls in 1944, and to date it has proved

satisfactory. Dissatisfaction was expressed by two farmers with mica type insulation, which filtered through the cracks around the doors and windows.

In central Minnesota, fewer farm homes were found insulated, but in most cases complete jobs were done. Louvers were installed in a large percentage of the houses. Most of the insulation in this area took the form of a paper or asbestos covering on the outside of the building. One farm home in Isanti County, built from 1943 to 1948, used wood shavings for wall insulation. No vapor paper was used, but the insulation is considered satisfactory. The owner plans to insulate the ceiling at some future date.

Use of Plywood and Fiberboard on the Farm

Only two farms contacted (one in each region) were found to have used plywood in any building. In each case it was used for wall and ceiling cover. One farmer also used 5-ply (outside) Douglas fir plywood for the floor of a bedroom. Both users were pleased with the plywood and planned to use more of it in other rooms.

Perhaps 20 percent of the farmers have used some type of wallboard in their houses. Doing the work themselves, the job of fitting was often poorly done, with ugly joints left, especially in the ceilings. The use of wallboard is somewhat commoner in central than in southeastern Minnesota.

At least 10 percent of the farmers have tried various types of wallboard for sealing and insulating chicken houses. In every case the chickens have eaten the boards wherever they could reach them. Those not destroyed have been saturated by moisture condensation and are badly sagged or even pulled away from the nails. Fairly recent installations indicate that wallboard is still being sold for chicken houses.

Prefabricated Buildings

Very few prefabricated buildings were found on the farms visited. General observation while traveling confirms this to be the general situation.

Several small ready-made brooder houses were used for summer housing of young chickens. About half of these buildings were purchased and the others made at home, partly of native and salvaged lumber. One farmer who did not own a large hog house, had several small individual farrowing houses.

Owners of these small buildings consider them satisfactory, but since no new prefabricated buildings have been put up on the farms since the war, it appears that farmers prefer a more permanent type of structure.

It is unfortunate that small portable buildings have not been more acceptable. Native, short-length lumber is excellent for their construction. Small turkey houses probably come in this group, although most of them are built on the farm.

Experience with Connectors and Unconventional Connections in Farm Buildings

Mechanical or other wood connectors, other than nails and a few wooden pins in old barns, were not noted on any of the farms visited. Their more general use might make it possible to utilize short-length lumber to a much greater extent than at present.

MARKETING OF NATIVE WOODLAND PRODUCTS

Nearly all the timber cut in southeastern and central Minnesota comes from the farm wood lot and is used on the farms. Although the timber area per farm is not appreciably greater than in southeastern Minnesota, central Minnesota farmers sell a larger part of their production.

As far as could be determined, native hardwood lumber is not handled by any retail lumberyard in southeastern Minnesota. Small quantities of northern Minnesota pine lumber were sold there during the war, but in general it was considered inferior to western and southern lumber and is seldom found in present stocks.

Most retail yards in southeastern Minnesota sell cedar posts cut in northern Minnesota, Wisconsin, or Michigan. Only an occasional independent retail lumberyard handles native oak posts.

Some native hardwood lumber and a considerable quantity of hardwood posts and lumber are sold to neighbors or at local farm auctions. These local transactions, however, represent but a small part of the wood-lot products harvested in southern Minnesota.

In southeastern Minnesota a few high-grade logs (mostly basswood and walnut) are cut and sold to veneer mills and a few woods-run logs to local sawmills; a small quantity of high-grade lumber finds its way into the Twin Cities hardwood lumber market; but of the timber cut, probably 80 percent is used on the farm where it was harvested. Very few stumpage sales are made in southeastern Minnesota.

Several retail lumberyards in central Minnesota have their own sawmills and cut part of their own lumber needs, chiefly from pine and aspen, although some hardwood is also produced. Since they are in competition with sawmill owners, several independent retail yards also buy and sell native lumber.

In central Minnesota, locally cut cedar and tamarack fence posts are handled by many yards; there is considerable sale of cedar and tamarack posts and pine and aspen lumber between farmers and also to the Twin Cities market; quite a few sawlogs are cut and sold to small sawmills; a considerable quantity of smaller timber is harvested and sold for pulpwood, excelsior wood, and wood conversion; probably less than half the lumber and posts cut are for home consumption; and stumpage sales are much more frequent than in southeastern Minnesota.

NEED FOR ADDITIONAL RESEARCH AND EDUCATIONAL EFFORT

Based on this study of native forest products used on farms in southeastern and central Minnesota, several recommendations can be made to aid farmers in improving their buildings and in making better use of native lumber from their own or neighboring farms. The apparent needs include (a) assembly and distribution in suitable publication form of practical information available to technicians but unavailable to farmers, (b) assistance in developing cooperative log conversion and lumberyarding facilities, and (c) developing and testing certain specific utilization measures.

A Handbook Needed

A basic "Farm Builders' Handbook" would be of great help to farmers and should include such information as:

1. The number of layers of different sized boards of various species needed to carry a given roof load (chiefly in curved roofs).

2. Correct spacing of rafters and the technique of bracing roofs (for curved roofs and other types).

3. Correct nailing practice for built-up rafters and timbers, including optimum size of nails, angle of driving and clinching, and the practice of nailing from the inside or outside of the rafter.

4. Method of using bolts in built-up rafters and timbers.

5. A simple diagrammatic plan for the rapid sawing of boards for round rafters (with a circle saw).

6. Proper techniques for bracing the ends of barns.

7. Minimum requirements for enclosing side walls and rafters in farm buildings.

8. Minimum pitch of roof for various types of roofing materials, such as cedar shingles, composition shingles, and galvanized iron. The minimum pitch of roof at which roof boards will not decay under cedar or composition shingles may be steeper than the pitch which will permit these materials to shed water satisfactorily. Correct pitch of roof is especially important where native lumber is used.

9. The use of built-up beams and posts, method of construction, and carrying capacity.

10. Insulating value of different building methods and materials, including both single and double-wall construction and combinations of materials.

11. Optimum use of vapor barrier paper.

12. Minimum requirements for ventilation and a brief plan for construction and adequate ventilation systems for animal-housing buildings.

13. The use of treated posts and lumber.

14. Minimum standards and techniques for grounding large metal roofs and walls against lightning.

15. The technique of sawing fence posts from rough logs. This will include size and shape of posts which are most durable and easiest to use.

16. The technique of sharpening and splitting posts with a circular wood saw.

17. The more important features on nailing farm buildings similar to the publication on "Techniques of Nailing Farm Buildings". Farmers were much interested in having this publication despite the fact that it is inapplicable to barns and similar buildings.

18. The relative durability of various fence post species.

19. A design for small lumber piles so that material can be removed without breaking down the entire pile. A design for a small lumber storage and drying shed is also suggested.

20. A table giving the approximate drying rates for different species and sizes of lumber.

21. Special information on wind-resistant construction, especially of barns.

Information on some of these suggestions for a Farm Builders' Handbook may not be available, in which case new research seems amply justified.

Cooperative Log and Lumberyards

Technical advice and assistance in the development of cooperative log and lumberyards in each of the central and southeastern Minnesota counties, probably would stimulate further use of native lumber.

As mentioned previously, farm buildings are usually constructed as the result of an emergency, such as fire and storms or unusually heavy field crops. As it usually takes several months to cut the trees, saw and dry the lumber, building lumber is more often purchased from the nearby lumberyard even when the farmer owns a large wood lot. It is unusual for a farmer to have a supply of dry native lumber on hand to meet emergency requirements.

A cooperative log and lumberyard would permit carrying a stock of air-dry native lumber, and exchanging it with farmers for newly cut logs. Each yard would need its own sawmill. There is also a place for semipermanent mills that can cut better quality lumber than the average portable mill. A planer and edger are necessary to supply lumber finished to satisfactorily close dimension and smooth surface.

A small dry kiln might be added for drying flooring and finished lumber. The cooperative yard might own an electric moisture determination meter which could be rented to farmers for use with air-dried lumber. Also, trucking services for both logs and lumber might be furnished.

Such cooperatives could work for improved wood-lot management as well as promote better farm-building practices. The proposed cooperative yard might logically treat fence posts and lumber.

Additional Research Needed

Most modern buildings are built for uniform durability. Research is needed both in design and materials used, so all farm buildings can be so constructed that all parts have about the same "life expectancy." In present buildings various parts have much different life expectancies. For example, the roof if properly covered with shingles, may last indefinitely; but the studding near the bottom and especially the sills are subject to moisture and are exposed to rot. Seldom does the lower part of the barn last as long as the upper part. Replacement of sills and decayed parts often is delayed until other sections are warped and sprung out of shape. Repairs are difficult and costly.

Redesign of large buildings, such as barns, might also effect a considerable saving of material, and make them easier to insulate and ventilate. Such a study would determine minimum safety factors for studding, floor joists, rafters, etc.

Other points needing study include:

1. Development of a simple wood-burning heating unit that can be used both for furnaces and space heaters. This unit might well be constructed to burn chips.

2. Development of a portable chipper--much like the portable feed grinder used on the farm--to supply chips for the wood-burning heater.

3. Permanently stained (bright colors) and fire-proofed cedar shingles should be developed and made available to the farm trade through retail lumberyards.

4. Cost studies (wood posts versus steel posts) in fence construction and maintenance under different conditions. This would include cost studies of tearing down and moving steel and wooden post fences.

There is need for cooperative work with the Portland Cement Company regarding recommended use of lumber in buildings. For example, plates are set on the side walls and no mention is made of the need to treat this lumber when used in poultry houses, hog houses, milk houses, or barn construction. Other features, such as insulation and the use of vapor paper could be included in the Portland Cement Company plans. The minimum standards for different spans should be worked out and included in the Farm Builders' Handbook.

There is evidence on many farms that lumber and the many substitute materials such as galvanized iron, hollow tile, and composition shingles, work against each other when used in livestock and poultry buildings. Most of these difficulties are attributable to moisture conditions created by the lighter wall coverings. Research is needed to determine how these various building materials can be used together harmoniously.

STUDY HIGHLIGHTS

This survey revealed ample evidence that there is a tremendous and little-explored field in farm-building design and construction which is worthy of the best research effort obtainable and whole-hearted follow up by extension work.

1. The use of short-length lumber in built-up rafters and timbers offers an excellent opportunity for the continued use of native lumber in farm buildings. Farmers need information on the best design and techniques of construction for these built-up members. This information should include proper degree of dryness, type and size of nails to use, sawing of rafters. Size and arrangement of structural members usually are based on a farmer's observation of a neighbor's barn rather than on sound building design data readily available to him.

2. Ventilation of animal-housing buildings is the greatest single problem in building design and use of materials on all farms visited. Many barns, hog houses, and poultry houses are excessively wet for long periods during the winter and spring. There is evidence on nearly every farm of excessive decay and the resulting shortening of the life of the building. The farmer is aware of this condition but usually considers it unavoidable. Substitute materials, such as native stone, hollow tile, and cement blocks sometimes are used for wall construction to correct this excessive moisture condition. A wider distribution of existing information is needed on how to get at the seat of the trouble. More research also seems needed. The use of nonwood materials in combination with wood to overcome shortcomings in the wood construction used in the past has introduced new complications. The old barn was cold but had adequate ventilation and no appreciable moisture problem. As tighter sheet materials, for example, are added, the building no longer "breathes" and moisture conditions become acute. There is ample evidence that wood and many of its substitute materials

are not working out well together in many of the animal-housing buildings. This deserves further study.

The farmer is generally dissatisfied with the frequency that painting is needed and its cost, and is constantly looking for a "way out". The use of galvanized iron, aluminum, composition shingles, and paper is increasing as a permanent covering not needing paint. These materials further complicate the venetilation of the buildings housing livestock.

Due largely to rotation farming and the frequent moving of fences, and to the increased use of electric fencing, steel posts are finding extensive use on Minnesota farms, and will probably be more widely used in the future. As long as available from the farm wood lot, native wooden posts will continue to be used in permanent farm fences.

Wood as a fuel for the farm house is rapidly being replaced by coal, oil, and electricity. Some reconversion to wood can be expected when farm income is at a lower level, but many farms now have a central heating plant and electric kitchen range unsuited to the use of wood. A considerable part of the fuel market has been permanently lost. The development of efficient, easy to operate, wood-burning units might recover a small part of the business, but not enough to absorb the fuel wood available from wood lots under good forest management.

The farmer does nearly all his own work in the woods and often has a saw-mill or has logs sawed by a neighbor with a mill. The farmer does a large part of his own building and repair work and nearly all the painting. This increases the need for supplying him with sound information on the use of lumber for farm buildings. At present the farmer has as a guide only his past experience or observation, which may be based on poor practices.